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ABSTRACT

Impacts from the major high technological changes now underway cut across all industrial sectors and most occupational clusters. Technological innovation can increase or decrease the total number of types of jobs. Decline in employment may be offset, however, by new applications and capabilities of goods and services or by employment shifts. While fairly clear estimates of where technology will affect industry have been made, it is not always clear what occupational titles are involved. Different studies have suggested varying occupational growth rates. A joint labor union-management program has been called for to ensure workers of an early-warning system of advanced information about management plans for future innovations that might cause job losses or other problems. More frequent skills upgrading of technical personnel will be required due to accelerating technological obsolescence. Job content and worker qualities will be increasingly modified. New linkages between the private sector and vocational education programs will be required to keep the curriculum current and graduates employable. As technological change occurs faster, a revolution will be seen in the need for and delivery of occupational information to keep individuals aware of labor market needs. (YLB)

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THE OCCUPATIONAL IMPACT OF SIGNIFICANT TECHNOLOGICAL INNOVATION:

HI—TECH and the JOBS FUTURE

RESEARCH REVIEW NO. 11

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The Occupational Impact of
Significant Technological Innovation:
Hi-Tech and the Jobs Future

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The degree to which technology increases or decreases the total number or types of jobs depends on the balance between the employment loss or shift-out from producing more output per worker and the employment gain or shift-in from new markets created by lower costs and new applications and capabilities of a good or service. While there may be no net employment loss or gain, on the other hand, it is possible that new technology can give a local industry the competitive edge. Such an edge might mean more local employment even though employment in the industry as a whole remains the same or even declines.¹

Technological change can cause job displacement especially when the industry is concentrated in a particular region or locality. Sometimes the employment impact is direct, as in the case of agriculture when machinery replaces labor. In most cases, however, the effect would be less obvious. Output does not advance at the same rate as productivity in all industries. Industries with greater applications of technological advances as a rule experience larger increases in productivity and vice versa, however.² As we near the limits of technological progress it will not be possible to increase one kind of productivity without a sacrifice of some other kind of productivity. Factors of production such as energy and capital may require a fairly substantial sacrifice in the growth of labor productivity.³ As energy costs rise the relative costs of mechanization and labor will come closer to balance.

In Britain, a 1979 study contends that micro-electronics will cut British employment by 23%, eliminating 5 million jobs by the year 2000.²⁰ However, it is not clear what assumptions are behind this estimate and to what extent it is just part of the larger picture of a long running decline of the British economy. The lack of an infrastructure to go into high technology industries to offset employment shifts and smaller scale and smaller markets may compound this basically unhealthy general economic outlook.

No really good, that is rigorous, study has been made of potential technological impacts. Austria may be an exception. An input-output model developed there has projected (to 1990) that full automation of the Austrian economy would give the highest growth in domestic product than other options but would also give the highest unemployment rate (10%).²¹ In this particular model, the unemployment rate could be dropped to 2% by shortening the work week (with a drop in the domestic product as well).

Industrial Impacts

A study at Carnegie-Mellon University asserts that the current generation of robots has the technical capacity to perform nearly 7 million existing factory jobs - one third of all manufacturing employment in the U.S. Some time after 1990, all manufacturing operatives will be replaceable. However, such estimates must take into consideration that the pace of innovation will depend on the relative costs of labor and computerized technologies, the rate of actual application or installation of new methods and constraints internal to the management of industrial organizations. Even the replacement of only 5% of all blue-collar workers in the Western industrialized nations would require annual investments of \$3 billion for the next forty (40) years.⁴

The major high technology changes underway in the U.S. range from robotics to telecommunications to bionics with impacts cutting across all industrial sectors and most occupational clusters. Microelectronics with its silicon chips is a leading area of innovation on its own in the form of personal computers and the potentiality of fifth generation "thinking" computers. Coupled with automated machinery the chip creates additional dramatic innovations in the manner of robots. Already a public issue, the next major impact of robotics will come with "seeing - feeling - smelling" computer-assisted machines. Earthbound and spaceborne telecommunication advances will greatly increase the amount, speed and quality of information flow. Optic fibers, millimeter tube microwave transmission, infrared transmission, full electronic telephone switching, and continued growth of satellite useage will all impact on job content, shifting, and qualities required of workers. ²

While office technology will be changing rapidly, there is little indication as to whether the result will be reduced office employment, shifts in future employment growth or simply higher levels of productivity in white-collar settings. ⁴ In 1960, clerical workers in the U.S. numbered about 10 million or 15% of the total workforce. By 1980, there were more than 18 million (19%), and clerical employment is expected to continue to grow significantly to 1990. Historically, the factory worker-equipment capitalization ratio has been \$25,000 per worker while for the office worker it has been a mere \$2,000. This capitalization barrier may well check the depth of office automation inroads. ² Even so, it is estimated that a \$125 billion increase in productivity could be realized through functional integration and office automation. ¹⁴

In retail trade a decline in the need for sales clerks due to electronic shopping may be offset by new types and numbers of retail products and outlets.

For tourism labor market areas these impacts may be minimal. Similarly in the service industries, despite automatic banking, self-directed accounting and legal software on personal computers and the like, continued growth is expected especially for the small business sector. Here, as well as in finance, insurance and real estate, continued growth and automation will not slow employment growth short of the advent of fifth-generation "sensory/thinking" computers. Such an advance is pure speculation right now, of course, and in any event the psychological acceptability in the marketplace would be a severe test of probable application and installation. But, again, this constraint will be differential across industries (tourists will want to deal with real people, not sensory robots).

Technological impacts in agriculture have, of course, been dramatic and obvious. The declining farm related workforce and enormous increase in productivity are well known. Further impacts of both an absolute and regional nature can be expected through innovations which make water cheaper (conservation), improve pest control (genetics, irradiation), save energy, and expand use of labor saving devices and machinery.

If there is any significant slowdown or even decline in employment in the manufacturing industries it would be amongst assemblers and mid-level managerial and supervisory workers. But again, these may be matters of employment shifts rather than slowdowns, i.e., an assembler being re-trained to become a robot monitor. And the rate of displacement, if any, would vary between industries and movement might take place from one type to another. It would be in the mature industries where declines would take place, such as in basic foods, paper, chemicals, autos, tires, major home appliances and the like. Continued growth would be expected in new product oriented industries. ¹

Currently (1982), Japan has 14,250 industrial robots in operation while the U.S. has about 4,100; West Germany, 2,300; and France, 1,000.⁵ By the end of the 1980's, General Motors expects to have 14,000 robots at work and Matsushita plans on having 100,000. In fact, one of Nissan's automobile assembly plants is 97% automated. In another example, one automated Japanese sewing machine factory produces 3,000 units a month with two workers where previously 26 workers produced 600 per month.⁵ By 1985, computer-assisted manufacturing in the U.S. is expected to be up 35% from 1979.¹³

Occupational Impacts

A good example of the slight disparity of analytical opinion on the real drift of technological impacts on occupations are the recommendations of Battelle on the strategy to develop high technology industrial employment in the State of New York.⁶ Battelle's study of 25 potential "hi-tech" industries maintains that New York needs to develop greater supplies of skilled workers. The greatest share of this supply would be amongst operatives including assemblers and non-precision machine operators. This, of course, is in direct opposition to the California study¹ which suggests that the demand for such occupations will be the first to decline beginning in the '80's. It also varies somewhat with the Bureau of Labor Statistics' projections for 1990, which show a slower than average growth for craft workers. Battelle holds that New York should promote the development of a pool of electricians, carpenters and tool and die makers as part of its high technology industrial development strategy.⁶

The California study¹ suggests below average growth for assembly workers, keypunch operators, retail sales clerks, bank tellers and secretaries and stenos. Above average growth is estimated in the study to occur for professional-

technicals, managers and service workers. These assessments are more in line with Bureau of Labor Statistics' 1990 projections for the nation as a whole. Analysis of the three level model used for 1990 (growth assumptions Low, High I and High II) indicate fastest occupational growth for service workers and second fastest for clerical workers, with professional-technicals running third. Blue collar and craft occupations are expected to grow at average or below average rates depending upon the industry. Managers and administrator occupations are expected to grow at slower rates.⁷ The BLS model is especially relevant to our concern for technological impacts. The three growth assumptions were constructed using five key variables of which productivity was the most sensitive in affecting variation in the growth trends. The importance of the interplay between technology, occupations and the economy is underscored by this central role of productivity. Purposeful decisions to improve the productivity of labor and capital will be made in the context of the general health of the economy and that health will be shaped significantly by the rate of application of technological innovation.

While fairly clear estimates of where technology will impact industry, it is not always clear what occupational titles are involved. As one forecasting consultant put it, "Everyone knows what a 'sunrise' industry is. But what are the 'sunrise' occupations? We're only beginning to identify them."¹⁸

Some of these 'sunrise' occupational areas are listed here:

<u>Occupational Area</u>	<u>Estimated 1990 U.S. Employment</u> ¹⁸
Industrial Robot Production	800,000
Geriatric Social Work	700,000
Energy Technicians	650,000
Industrial Laser Processing	600,000
Housing Rehabilitation	500,000
New Synthetic Materials Handling	400,000
On-line Emergency Medical	400,000
Hazardous Waste Management	300,000
Genetic Engineering	250,000
Bionic Medical Electronics	200,000
Laser, Holographic, Optic Fiber Maintenance	200,000

Collective Bargaining

In the White House Fact Sheet accompanying President Carter's Message on Industrial Innovation (October 23, 1979) it is stated that the President directed the Secretary of Labor and Commerce to work jointly with labor and management to develop a national Labor-Technology Forecasting System.⁸

This proposal was in line with recommendations made by labor union representatives sitting as the Labor Subcommittee to the Advisory Committee on Industrial Innovation. Their report called for a joint program to insure workers of an early warning system of advance information about management plans for future innovations which might affect workers with job losses or other problems.⁹ The Subcommittee also called for the federal government to establish a clearinghouse to gather, on a continuing basis, information on innovation and its effects on jobs, skills, training needs, and industry location.

This approach has been taken in Europe where there is generally more anxiety about the possibility of technologically-induced layoffs. In a major Xongsberg, Norway factory the trained union technology committee received complete information before the computerized machine tools were installed.¹⁰ The committee insisted that machine operators already on the job be trained to do the computer programming and repairs. As a result, the machinists' skills were broadened rather than narrowed by the technological change. In contrast, at a Lynn, Mass. plant, the equipment was installed without consultation. Now supervisors and non-union programmers handle the computer work thereby reducing many skilled machinists to what they think is less interesting, lower paying, button-pushing work. Even in Japan, labor unions are asking for a stronger voice in consulting with management on robotic installations.¹²

An article in the Harvard Business Review puts it, "... if unions are to have a presence and impact in the postindustrial workplace, they need to be involved in rethinking the concepts of management's prerogatives and how work gets done." ¹⁶ Within-plant and interplant transfers, retraining, relocation assistance, counseling, severance pay, pension rights, seniority protection, and unemployment (dislocation) benefits can all help cushion technological displacements. ¹⁷

Education and Training

Significant public issues are raised from expected technological impacts, mainly in the area of worker preparation, individual competencies, and retraining. It can be expected that technical personnel will require more frequent skills upgrading due to accelerating technological obsolescence. Managers and supervisors increasingly will require substantial computer literacy and the general public will have to become technologically literate through general education systems. ¹

The content of jobs and the qualities required of workers will be increasingly modified. Even now there is less demand for manual dexterity, physical strength for materials handling, and for traditional crafts. In contrast, employers are placing more emphasis on formal knowledge, precision, and perceptual aptitudes. As many manual tasks are mechanized, unskilled workers become monitors of very expensive equipment. The reduction of repetitive tasks that are so dissatisfying to the industrial worker may be welcomed, but the isolation and constant monitoring associated with advanced technology can create new stress. ² A study of robotics in the Italian auto, white goods and color TV industries showed a decline in skills needed by new equipment workers but skills of maintenance workers and auxiliary staff had increased

dramatically.¹⁹

Fundamental skills will continue in importance as the ability to read and write at a functional level increasingly becomes mandatory in order to interpret operating instructions of complex equipment. Additionally, these basics play key roles in the retraining of affected workers for new skills and new skill levels. While these fundamentals are public education issues, the technical upgrading of workers will continue to be accomplished "in-plant" through on-the-job and classroom instruction. The faster things change the greater will be the pressure from the business sector on the public education sector especially relative to vocational education programs. As one Presidential Commission put it: "One oft-cited problem is that vocational programs train students on obsolete equipment for obsolete skills. To improve the performance of vocational education programs...[we urge]... the creation of new linkages between the private sector and schools so that curriculum can be kept current and graduates will be employable." 11 Or as one Briton has put it, "The new technologies put a premium on skilled and qualified people... they offer few opportunities for the unskilled and the uneducated." 15

While the demand for traditional, full-time degree oriented education is levelling off the demand for specific or continuing job related education is growing. The trend toward a growing information and service oriented economy is creating an increasing demand for education in engineering and science, particularly computer sciences, at all levels.²²

Occupational Information

Futurists say that the 80's will be the decade of information as a sophisticated post-industrial economy is rebuilt on microprocessors and satellites in the same way that the industrial society was built on iron rails and steel girders. The 80's, therefore, will see a revolution in the

need for, and delivery of, occupational information. They will, in fact, be the Decade of Occupational Information. Technological change will be faster and many specialized jobs will be outmoded almost as quickly as they arise. Increased life expectancy and a higher birth rate will combine to push up population. Overall average age of the population will rise and retirement will come later as economics and medical advances unite to prolong working years. Job market shifts will require more mid-career occupational changes, and postponed retirements will reduce job openings available for youth. Education and training programs will have to become more sensitive to the coming changes in the labor market. Individuals, both young and old, will need a heightened awareness of what to expect when they enter the labor market and when changing occupation in mid-life.

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